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Statistical Control

We are a little surprised that nobody in the British foundry industry has yet come forward with a Paper on statistical control of foundry operations. We are aware that such studies are in progress, and that they are productive of much good. It may be that time has been insufficient to collect adequate data, or that there are too many variables in foundry practice to draw rigid conclusions. Much depends on the background of the responsible executive. One may be keen on sand control, and would from experience set a datum line of, say, 4 per cent. moisture content and plot each day's wasters against variations from this standard. Another may have a "bee in his bonnet" as to the crucial effect of pouring temperature of the metals entering the mould and correlate any deviations with the scrap. A third may have an exaggerated notion of the effect of slight variations in the tin content in a gunmetal or the carbon plus silicon content in cast iron and use these figures in conjunction with the scrap losses. Similarly the tensile properties, or the ramming hardness number taken on the same spot of a series of castings, may be used by others. Naturally the selection of material for the production of data will not only depend on the idiosyncrasies of the foundry manager, but also with the nature of the castings being made. The great advantage of statistical control, however, is that its prosecution will quickly show up whether the management is on the right track. Usually some statistics exist in every foundry, and some effort made in the direction of plotting them by the newer methods will quickly reveal whether a pet theory is or is not tenable. A series of charts examined in conjunction with an established quality level will focus attention on where deviation from standard tolerances has thrown quality so far from normal as to place it into the category of scrap. Furthermore, the creation of such a control gives confidence to the management to experiment because they have the certainty of knowing immediately whether the results are beneficial or detrimental from a straight quality point of view. Gating methods of running lend themselves well to such a mode of expression. For instance, one might take 24 hours before and after the change and correlate these periods with the casting quality as expressed in rejects per hour. The wise management of to-day attaches as much importance to this particular form of industrial research as it does to that resulting from the efforts of the research staffs. This is no place for detailing the *modus operandi* of statistical control, and those unfamiliar with what is implied should consult "Engineer's Manual of Statistical Methods," by Major L. E. Simons, the creator of the new system, or the Symposium on the subject organised by the Institution of Mechanical Engineers. The difference between statistical and scientific research is that the former requires but paper and pencil, and one or more people depending on the size of the works to operate the system. We have previously dealt with this subject, and do so again in the hope that it will induce someone to come forward and give the industry the benefit of his experience.

Deoxidation with Beryllium

In a series of studies on the properties and metallurgical uses of beryllium, reported on in "Metallurgia Italiana," L. Losana devotes one Paper to the oxidation of steel using beryllium. He compares the deoxidising actions of manganese, silicon, aluminium and beryllium, and gives the principal formulæ and data for Be in so far as they affect the separation of the oxide and the reduction of iron oxide. Deoxidation constants at different temperatures show that a few per cent. of Be gives complete deoxidation, a much better result being obtained than with Al.

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INSTITUTE OF BRITISH FOUNDRYMEN

PAPERS FOR THE ANNUAL MEETING

The following Papers have been promised for the Annual Meeting, which is to be held at the Waldorf Hotel, London, on June 26, 1943. For the purpose of discussion the Papers will be presented in three sessions, the details of which will be announced later.

Edward Williams Lecture: "The Contribution of the Steel Founder to Marine Engineering," by Dr. S. F. Dorey.

"Hot Tears in Steel Castings," by Mr. Charles W. Briggs (Technical and Research Director of the American Steel Founders' Society) (American Foundrymen's Association Exchange Paper).

"The Continuous Production of Manganese Steel Castings from the Tropenas Converter," by Mr. L. W. Bolton and Mr. J. Hill.

"A Wartime Steel Foundry—Some Problems and Developments," by Mr. E. Derek Wells and Mr. A. Johnson.

"Some Aspects of the Production of Malleable Iron Castings," by Mr. J. Roxburgh.

A Paper on "Foundry Education," by Mr. G. L. Harbach and Mr. J. R. Horton.

"The Effect of Casting Conditions on the Properties of a Magnesium Die Casting Alloy," by Prof. W. R. D. Jones.

"Report on Copper-Antimony-Nickel Gear Alloy," by the Non-Ferrous Sub-Committee.

"The Spectrographic Analysis of Cast Iron," by Mr. F. B. Ling, Mr. J. McPheat and Mr. J. Arnott.

"Meeting the Raw Materials Supply Position," by the Cast Iron Sub-Committee.

"A Method of Correlating Foundry Procedure and Quality of Castings," by Mr. H. G. Warrington.

SCOTTISH BRANCH

Annual General Meeting

The annual general meeting of the Branch, followed by a question night, was held at the Royal Technical College, George Street, Glasgow, on March 13, 1943, Mr. A. N. Kirby presiding.

After the minutes of the last annual general meeting had been approved, Mr. John Bell, the honorary secretary, presented his report, in the course of which he said the session 1942-43 showed a decided advance on any of their recent years, and in every way it deserves to be ranked as a most successful one. This was evident in many ways, and not least in the attendances at Branch meetings. As in previous years, six meetings were arranged for, and of these five had been held. A year ago the average attendance over the session was 39, but for this session it was 64. A year ago the maximum attendance was 50, while this session it was 91, followed closely by another meeting with an attendance of 89. The lowest attendance last year was 21, but this year the lowest was 43, not much less than the maximum a year ago. Four meetings of the Council were held during the session, the attendances being, maximum 12, minimum 8, and average 11. The corresponding figures for last session were 13, 7, and 9. The result of this increased interest was reflected in their membership, which had jumped up to 317, a figure which was the highest they had ever reached and was well above the 300 mark which was so elusive a few years ago. The net increase in membership was 25.

During the session only three members resigned, and only two were struck off, but unfortunately six have been removed by death. These were Mr. N. McManus, Mr. John McArthur, Mr. James Ross, Mr. T. N. Goodwin, Mr. John Forrester, and Mr. Thomas Blackadder.

Like the parent Branch, the Falkirk Section had had a satisfactory year, due largely to the enthusiasm of the Secretary, Mr. T. R. Goodwin, and the work of Mr. Wilson and his committee. It had been an outstanding year. One event which undoubtedly helped to make it so occurred in October last. It had generally been accepted that due to wartime conditions works visits could not be arranged. But an opportunity was given just before the beginning of the session to arrange a visit to the foundries of an important aero-engine works. The invitation was made possible by the kindness of Mr. J. Vickers, manager of the foundries, and was readily accepted by the Council. Naturally, rigid conditions had to be observed, but the helpful and sympathetic manner in which these were planned by Mr. Vickers and his staff made it an easy job for the Branch to complete their arrangements and to conform to the required conditions. No less than 112 members indicated their intention to be present, and although the weather was on its worst behaviour that night more than 100 members attended. From all sections were heard tributes to the works' directors and to Mr. Vickers for having made the visit possible and so full of interest. It had been, possibly, the most important single factor in the life of the Branch since the war began, and to the general manager of the company, to Mr. Vickers, Mr. McDougall and all the staff who did so much that night the Branch again expressed its sincerest thanks.

Finance.—A record balance was presented with the subscription revenue totalling over £400, with the expenses virtually stationary.

The following members were elected to the various offices:—*President:* Mr. D. H. Young; *Senior Vice-President:* Mr. Tom Shanks; *Junior Vice-President:* Mr. T. Tyrie, B.Sc.; *Members of Council:* Mr. W. Y. Buchanan, Mr. Wm. Dickie, and Mr. R. Macnab; *Representatives to General Council:* Mr. R. Ballantine, Mr. W. Y. Buchanan, and Mr. T. Tyrie, B.Sc.; *Representatives to Technical Committee:* Mr. John Arnott, F.I.C., and Mr. J. W. Donaldson, D.Sc.; *Hon. Secretary:* Mr. John Bell.

American production of malleable iron castings in 1942 totalled 768,496 net tons, against 843,038 tons in 1941 and 565,923 tons in 1939, according to the Bureau of the Census, Department of Commerce. Orders booked during the 12 months of 1942 totalled 859,102 tons, a decrease of about 25,000 tons, as compared with 884,881 for 1941, but an increase of nearly 290,000 from the 1940 level of 571,929 tons.

RADIOGRAPHY AS AN AID TO FOUNDRY TECHNIQUE*

Gamma-Rays in the Routine Testing of High-Conductivity Copper-Alloy Castings

By W. GLADWELL

In any gathering of foundrymen discussing the problems involved in making sound castings, one remark is almost invariably heard—"If only we could see everything that happens inside a mould during the pouring and solidification of the metal, the making of sound castings would be merely a routine business." Until it is possible to see inside a closed mould, such information will not be forthcoming. E. M. Currie's film, shown at the London Branch, went a long way towards providing it, but when part of the top half of the mould has to be removed, the question will still remain: "Does a fully closed mould behave in the same manner?" Until this information is available in full, an efficient substitute can be found in seeing inside the finished casting.

In order to achieve this, castings can be cut through at points where cavities are expected. There are several difficulties in this method, the most important being consequent on the fact that in a modern foundry making high duty castings, the position of gates and risers and the pouring temperature are no longer left to the individual moulder. These are, however, settled by the foundry foreman, who, if he has the casting cut up, will have it cut where he expected difficulties, having already taken precautions against them. Again, in non-ferrous metals, fine gas porosity may be completely obscured on the cut face by the action of the saw teeth. The specimen will then require polishing, and may need etching if this trouble is to be detected. On high-grade loose pattern work, an important consideration is that, if the initial moulding technique is proved correct, a casting in small pieces is one casting less to sell.

On the other hand, non-destructive testing by radiography shows where the faults, if any, really are—sometimes a quite surprising feature—and at the same time leaves the casting intact.

It is not necessary for the purpose of this Paper to delve deeply into the technique of radiography, this being the affair of the radiographer, since foundrymen are more concerned with the information to be gained from the radiograph than the method of obtaining it. However, for the sake of clarity, before dis-

* A Paper presented to the London Branch of the Institute of British Foundrymen, Mr. R. B. Templeton presiding, and The Metropolitan Chapter, and the American Foundrymen's Association, Mr. Fred G. Sefing presiding.

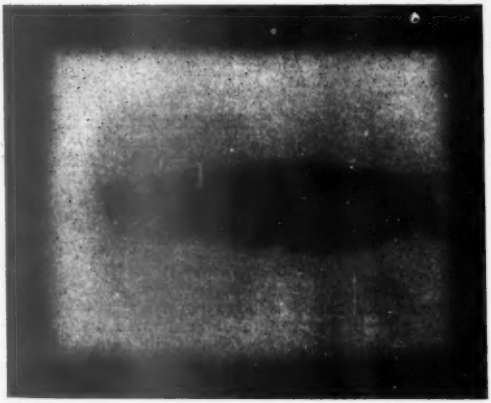

FIG. 1.—RADIOGRAPH OF A BLOCK OF COPPER CONTAINING A LARGE SHRINKAGE CAVITY, TO ILLUSTRATE PHOTOGRAPHIC CONTRAST OBTAINED.

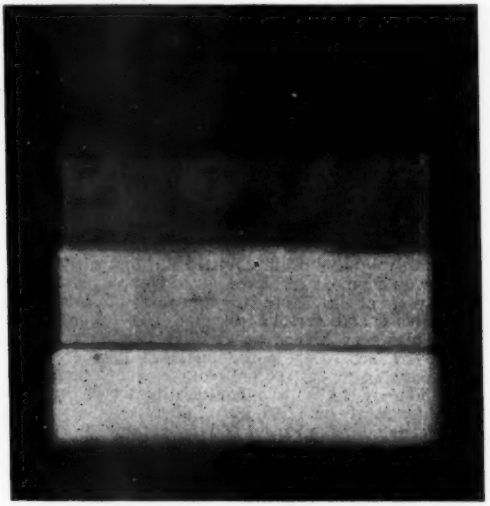

FIG. 2.—SHOWING A STEP BLOCK RADIOGRAPHED BY GAMMA RAYS.

Gamma-Radiography in the Foundry

cussing the probable value of radiography to the foundry, it has been considered necessary to give the following description of the method of obtaining a radiograph, and a comparison of the merits and limitations of the methods of radiography. For anyone wishing to go more thoroughly into the subject, much literature is available, two notable examples being "Engineering Radiography," by V. E. Pullin, published by G. Bell & Sons (London), Limited, 1934, and "Industrial Radiography," by St. John and Isenburger, published by John Wiley & Sons, New York, 1934.

Technique of Radiography

Radiography is not new to the foundry trade, and in fact radiographic examination of metallic articles was accomplished about 1900, and by 1930 it was well established as a method of testing in the light alloy field. Its more universal application was, however, probably hindered by the fact that whereas the short exposure times allowable before overheating, and the comparatively low voltages used in the early X-ray tubes would quite satisfactorily radiograph light alloys, they were of little use to founders of the denser non-ferrous and ferrous alloys. The latter require X-ray plants of higher penetration ranging from 100 to 400 kv. according to the thickness they are likely to encounter, or a radium source of gamma rays, corresponding to X-rays emitted by an X-ray plant operating at about 1,500 kv. Industrial X-ray equipment capable of giving 1,000 kv. are in use in the U.S.A.

The results of X-ray and gamma ray examination are recorded on a photographic film, a radiograph, which provides a permanent record. X-rays can also be viewed on a fluorescent screen, when the record is non-permanent, and the results are noted by the radiographer at the time of the examination. As this latter method is limited to thin sections of the heavier metals, it does not directly concern this Paper.

A radiograph is obtained through the ability of a percentage of the X-rays emitted by an X-ray tube or the gamma rays emitted by a quantity of radium to pass through objects opaque to light, and then to react on the emulsion of a photographic film, the quantity of radiation reaching the film being governed by the density and thickness of the object being examined. Thus, one inch of aluminium will not absorb the rays and consequently will not reduce their intensity to the same extent as one inch of copper, and the latter will not reduce their intensity to the same extent as two inches of copper.

These variations of intensity reaching the film affect it to different degrees, resulting in what is called photographic contrast on the film. A simple illustration of this is obtained by exposing a film in a light-tight container to a uniform beam of the rays, with no object in their path. On developing the film, no photographic contrast will be seen, that is, the film will be of uniform density over its whole area. If a second film, part of which is now covered by a block of sound metal, be exposed to the beam of rays, the developed film will show a photographic contrast, that is, two distinct densities or shades—dark on the uncovered background, and lighter in the area screened by the block of metal.

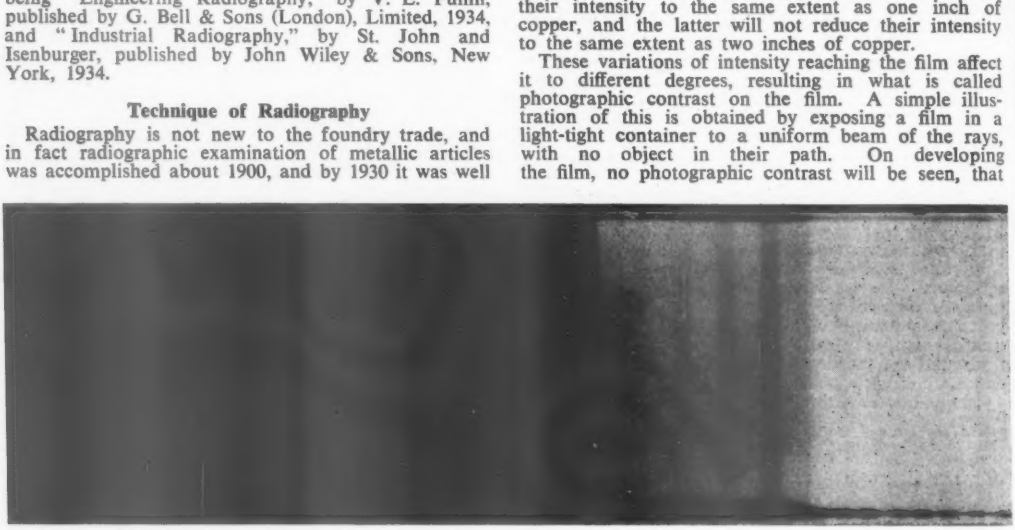

FIG. 3.—STEP BLOCK RADIOGRAPHED BY X-RAYS.

If the block of metal contains a cavity, another density will be recorded on the film. This is illustrated in Fig. 1, which is a radiograph of a block of copper containing a large shrinkage cavity. This radiograph will be seen to contain three distinct densities—the dark background, the light area where the rays have had to penetrate the full thickness of metal, and the intermediate shade where, owing to the cavity, the rays have not had to penetrate the full thickness of metal. The difference between the latter two densities is the photographic contrast on which the ease of detection of the cavity depends. The smaller the cavity, the lower is this contrast, and the more difficult it is to see its image on the radiograph.

Determining Volume and Location of Cavities

To know that a cavity exists in a casting, though useful, is not sufficient to justify the use of radiography. What is important is to be able to determine its volume and position in the casting.

To ascertain the volume of the cavity three dimensions must be known. Of these, the two at right angles to the direction of the rays can be determined by direct measurement of the image of the cavity on the radiograph. In order to determine the extent of the cavity in the direction of the rays, the radiographer aims at a standard density on that part of the radiograph corresponding to the section of the casting it is desired to examine. This standard density is obtained by varying the time of exposure according to the density and thickness of the section. The extent of the cavity can then be determined, by comparison with a set of standard films. Fig. 2 is an example of such films prepared by the gamma ray method. This shows various thicknesses of copper in steps of 1, 2, 3 and 4 in. Each of these steps contained artificial flaws corresponding to 2, 4, 6 and 8 per cent. of the total thickness of each step. The 4 per cent. markers are easily apparent on each step. Fig. 3 was prepared by the X-ray method. This shows various thicknesses of steel in steps ½, ¾ and 1 in. Each of these steps had slots machined in it to a depth corresponding to 1, 2, 4 and 8 per cent. The 2 per cent. markers are easily visible on each step.

The location of the cavity in the casting may be found by one of three methods. This factor is important if the normal routine examination has shown a cavity, the size of which does not obviously proclaim the casting scrap.

Of these methods, the most obvious consists in taking another exposure at right angles to the routine exposure. From the two films it is comparatively simple to determine the exact position of the cavity. This method is, however, limited by the shape of the casting, for there may be only one plane it is possible to penetrate successfully.

Of the other two methods, the following involves the use of two extra films and requires a stereoscopic viewing box. Two exposures are taken on separate films through the same plane, the source of the rays being moved a given distance parallel to the film between the exposures. The two films viewed simultaneously using stereoscopic principles give a three-dimensional appearance which allows of judging visually the position of the cavity. This method is particularly useful for the detection of cracks.

The last method relies on a geometric calculation to determine the position of the cavity. One extra film only is required, the exposure being split into two parts, the source of the rays again being moved parallel to the film between the two parts of the exposure. Two images of the cavity will be recorded on the processed film, and its position can be calculated from

FIG. 4.—HIGH-CONDUCTIVITY COPPER-ALLOY CASTINGS FOR SWITCHGEAR PARTS, REPRESENTING THE LIGHTER TYPE OF CASTING TO BE RADIOGRAPHED. SECTIONS MAY VARY FROM ¼ TO 1 IN. ON ANY ONE CASTING.

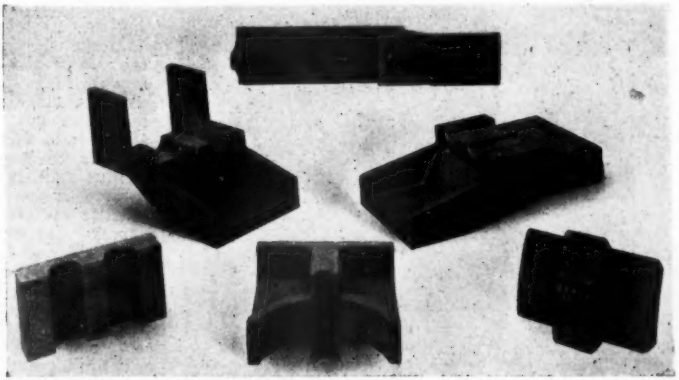

FIG. 5.—HEAVY COPPER-ALLOY CASTINGS FOR ARC-FURNACE CONSTRUCTION, WEIGHING UP TO 3 CWTS. EACH.

Gamma-Radiography in the Foundry

the distance between the two images of the cavity, the distance the source was moved, and the source to film distance.

Relative Merits of X-rays and Gamma Rays

The photographic contrast obtained with X-rays for thinner sections of heavy metals is very marked, and on work of uniform section thickness, this pronounced contrast proves of great assistance in the detection of small cavities. On castings of varying section thickness, however, this great contrast proves too effective. For example, when radiographing a casting varying by more than about ½ in. in section, the correct exposure is calculated for the thicker section, unless the X-ray beam is heavily filtered, the density obtained on the part of the radiograph corresponding to the thinner section will be so great as to be almost opaque to any but the brightest viewing lamp. Also, scattered radiation from the over-exposed portion will tend to obscure the image on the correctly exposed portion.

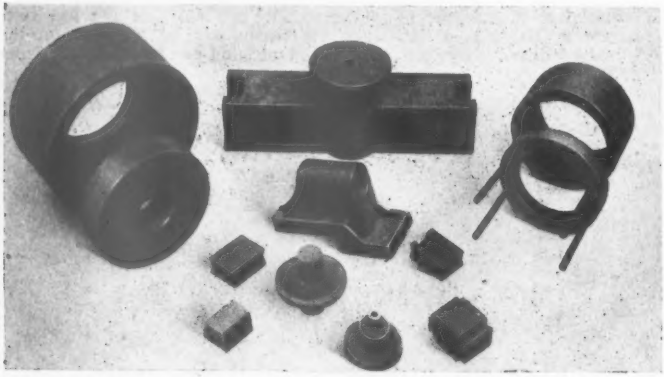

FIG. 6.—HIGH-CONDUCTIVITY COPPER-ALLOY CASTINGS FOR RESISTANCE-WELDING MACHINE PARTS WEIGHING FROM 3 LBS. TO 3 CWTS. THIS ILLUSTRATES THE SIMPLE OUTLINE BY HEAVY SECTIONS REQUIRED TO BE CAST FOR THIS PURPOSE.

Various techniques have been evolved to overcome both these difficulties. In principle they are all the same, and consist in building up the casting to an even thickness. On castings with flat faces, sheet metal may be used to build up the thin sections of the casting, whilst irregular castings may be surrounded by metal shot in a container just large enough to cover them.

The photographic contrast obtained with gamma rays is not so pronounced as in the case of X-rays, and this makes the detection of small cavities rather more difficult, as they will not be recorded with such a marked contrast, although it permits of radiographing castings up to about 3 in. change in section thickness without taking special precautions to guard against excessive densities or fogging due to scattered radiation.

FIG. 7.—A SIMPLE CASTING IN A COBALT-BERYLLIUM-COPPER ALLOY (see FIGS. 8 AND 9).

Modern X-ray tubes being mechanically cooled are capable of allowing longer exposures than the earlier models. For industrial purposes, however, exposures of more than one hour are rarely given. From this fact, and the fact that the highest voltage plants available in this country are about 400 kilovolts, it is possible to assume that the maximum sections in ferrous and heavy non-ferrous casting alloys which it is possible to radiograph in normal X-ray industrial practice in this country is about 4 in. The actual figures are probably slightly higher for ferrous materials, and lower for copper base alloys.

Exposure times for gamma-ray radiography of thinner sections are considerably longer than for X-ray examination. For example, a 400-kilovolt X-ray tube will radiograph an inch of copper in about 20 secs., compared to an exposure of about 15 min. for a 250 milligramme radium source, all other conditions being equal. This ratio falls very rapidly with increase in section, until at about 4 in. of copper the exposure times are roughly equal at an exposure of about 2 to 2½ hrs.

Gamma-ray radiography is non-mechanical, so that the maximum length of exposure time is governed solely by the length of time that the radium source can be economically spared on any one job; this makes possible such claims as to have radiographed a 12-in. section of steel.

Application to High-Conductivity Copper Alloys

The examples to be shown later are gamma-ray radiographs of castings made in a series of high copper content alloys. These alloys, with their particular properties of high electrical conductivity and high strength, were specially produced to make possible the reduction in weight and bulk of castings designed to carry heavy electrical currents, such as switchgear contact bars and current carrying parts of arc furnaces and of resistance welding machines.

To obtain the maximum benefit from such alloys it is obvious that the castings must be sound. A. B. Kinzel sums this up very aptly in the conclusion to his Paper, "High Conductivity Copper Alloys," in which he says: "In the last analysis all of the prescriptions and specifications are intended to apply to sound castings, and all of the predictions for high conductivity and high strength are based on the assumption that the foundryman will produce such castings."

In an attempt to achieve this desired soundness, it was decided to introduce radiography in order to give the personnel of the foundry engaged in making castings in these alloys a guide as to the efficiency of the moulding and melting methods practised in the shop.

Gamma-ray radiography was chosen for two main reasons:—(1) The varying section thickness and high density of the castings likely to be encountered; and (2) the low cost of examination. The size and shape of the castings were rather difficult to visualise, since with a comparatively new series of alloys the full range of possible applications could not be foreseen. Figs. 4, 5 and 6 illustrate the present range. The section thickness, coupled with the high density of some of these castings, determined very definitely that an X-ray plant below 250 kilovolts would not cover the whole range.

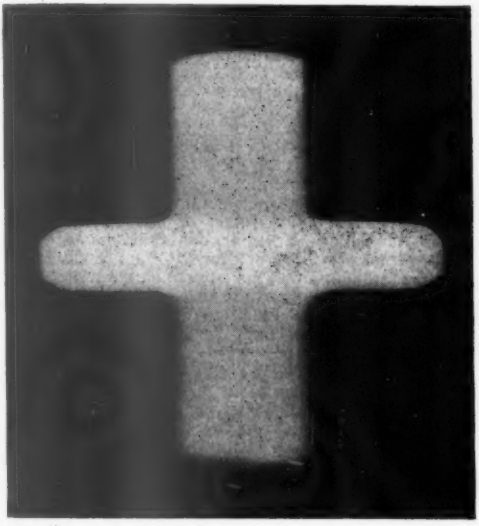

FIG. 8.—GAMMA-RAY RADIOGRAPH OF THE CASTING SHOWN IN FIG. 7.

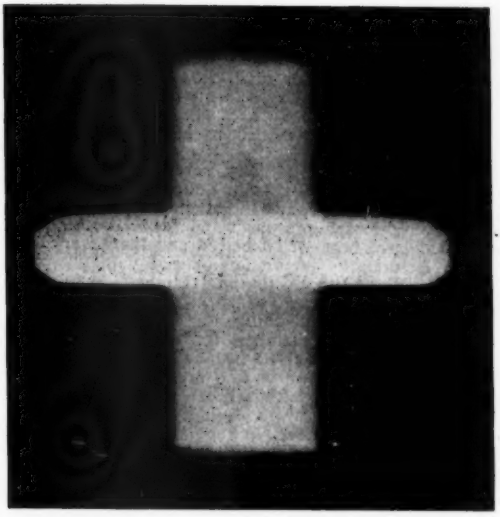

FIG. 9.—RADIOGRAPH OF THE CASTING IN FIG. 7 AFTER ALTERING METHOD OF RUNNING.

The initial cost of a 250 kilovolt X-ray plant is roughly the same as for a 250-milligramme radium source, but running costs are much lower with gamma rays. In Vol. 47 of the Transactions of the American Foundrymen's Association, the 1939 Radiography Committee quote the following from H. H. Lester's Paper on radiography: "It is possible for the small manufacturer to use gamma rays where he could not afford to maintain an X-ray plant."

Method of Running

The first example (Fig. 7) is rather a stock one, since most foundry text-books point out the possibility of shrinkage at such a joint in sections. Cast

(*Continued on page* 8)

NOTES FROM THE BRANCHES

EAST MIDLANDS BRANCH

The annual meeting was held at Loughborough College on Saturday, April 10, 1943, Mr. G. L. Harbach presiding. The following officers were elected for the 1943-44 session:—

As *President*, Mr. W. H. Smith; as *Senior Vice-President*, Mr. F. G. Butters; as *Junior Vice-President*, Mr. R. F. Orme; as *Hon. Secretary*, Mr. S. A. Horton; as *Auditors*, Mr. A. B. Bill and Mr. R. H. Buckland; as *Representatives on General Council*, Mr. A. E. Peace and Mr. F. G. Butters; as *Branch Representatives on the Technical Committee*, Mr. A. E. Peace and Mr. P. A. Russell. The following members were elected to the Branch Council to serve for three years: Mr. W. Niven, Mr. H. P. Radford and Mr. A. B. Bill.

Secretary's Report.—The 1942-43 session had been one of the most successful in the history of the East Midlands Branch. The E. J. Fox Gold Medal was awarded to Mr. P. H. Wilson; the Oliver Stubbs Medal was awarded to Mr. S. H. Russell; and Institute Diplomas were awarded to Mr. A. B. Bill and Mr. F. G. Butters.

Despite wartime conditions, seven very successful meetings have been held in Loughborough, Derby, Leicester and Newark, and the attendances at all meetings have exceeded pre-war standards. The subjects presented have been well received and thanks are due to the lecturers. The session opened with a works visit to Worthington-Simpson, Limited. As this was the first works to be visited since the commencement of hostilities, it was very much appreciated by those members fortunate enough to be included in the party. The Branch subscriptions were again a record.

The meeting closed with a hearty vote of thanks to the President for his work during the session, which was proposed by Mr. H. Bunting, who said that the increased attendances at the meetings proved the members did appreciate the efforts made on their behalf by the President. It was seconded by Mr. W. C. Marshall. A short Paper competition was then held.

Annual Dinner

The annual dinner was held at Derby on March 26. About 60 members were present. MR. LAWSON, works manager, Worthington-Simpson, Limited, who proposed a toast to the Institute, pointed out that the Costings Sub-committee's recommendations were making a direct attack on indiscriminate costing at a set price per cwt. or lb., and the advice of the Institute was being solicited on the many problems directly occasioned by the war, such as low-tin and silicon bronzes, alternative pig-iron mixtures and fuel efficiency. He expressed his personal appreciation of advice received from Mr. T. Makemson, the secretary of the Institute, in his capacity as Joint Director for Iron Castings.

MR. T. MAKEMSON, in responding, said, prior to the war the Institute's prestige had been founded on steady progress and gradually enlarging usefulness. In 1939, with full recognition of its technical standing, the Institute's Technical Committee pioneered the interpretation of research into practical foundry work. After 1939 and a brief spell of bewilderment, the Sections and Branches have continued a modest but normal routine up to the present time, while technical sub-committees did more work now than in pre-war days. Normality was a doubtful asset in this war, but in their case it was of direct assistance to members, firms and all associated with the war effort.

Mr. Makemson thanked Mr. Lawson for his able expression of appreciation of the Institute's work, and particularly stressed the need for maximum efficiency in technique and equipment to face the post-war competition from weldings, die-castings and plastics, etc. This year's volume of the Proceedings of the Institute was in every way excellent, and for that he thanked Mr. J. Bolton, acting secretary of the Institute.

MR. H. J. READ, chairman of Lincoln Section, proposed the toast of the East Midlands Branch, pointing out that out of the last six awards of the Oliver Stubbs Gold Medal, four had come to the East Midlands.

MR. G. L. HARBACH, President of East Midlands Branch, responding to Mr. Read, appealed for a fair deal for foundry apprentices; teach them their trade and keep their interest alive, not leave them to pick it up haphazardly by force of association. The foundry was the home of individual craftsmanship still, but the broad principles of foundry practice should be made the foundation of an apprentice's training.

MR. W. H. SMITH gave the toast of "The Visitors," which was replied to by his Worship the Mayor of Derby (Alderman A. Hind, J.P.).

Atmospheric-Pressure Feeding.—The principle of using atmospheric pressure in feeding steel castings is being applied to a wide variety of castings in America, from the simplest valve casting to the most intricate tank armour or turbine casting, writes W. H. WORRILOW, president, Lebanon Steel Foundry, Lebanon, Pa., in "Steel." The percentage of yield of good castings to melt shows a marked increase. Intensive use of this principle, plus the full and proper use of the directional solidification, mark two of the greatest achievements in steel casting, he considers.

RADIOGRAPHY AS AN AID TO FOUNDRY TECHNIQUE

(*Continued from page* 7)

in a cobalt-beryllium-copper alloy, this casting was originally bottom-poured through a choke gate in an endeavour to obtain a clean skin, free from oxide dross. A top feeder head capable of containing an equivalent weight of metal to that in the casting was employed to allow for liquid shrinkage. The resulting casting was far from satisfactory, as is shown in Fig. 8. This porosity was eliminated by the use of a mould with a similar feeder head, by removing the small ingate and pouring through the feeder. The sound casting obtained is shown in Fig. 9.

(*To be continued.*)

OXYPROPANE CUTTING IN THE FOUNDRY

A NEW DEPARTURE IN CUTTING TECHNIQUE

The use of propane as the fuel in cutting operations in the American steel and foundry industries is described by GERALD E. STEDMAN in "Steel." Results were far from satisfactory when propane was first employed, partly because the original torch equipment was incorrectly designed and the resultant oxygen consumption was out of proportion to the efficiency achieved. That unfavourable impression became widespread, although a few designers finally began to give oxypropane cutting the exclusive engineering attention it deserved and started to develop original torch and tip designs that finally have eliminated its original disadvantages.

The comparatively low flame temperature of propane in oxygen of 2,920 deg. C. appears to be of material benefit in most types of cutting operations. Steel sections up to 34 in. in thickness have been cut successfully by oxypropane without the use of an oxygen lance. Due to its excellent performance, industrial uses of propane have been gradually extended. In the Pittsburgh steel district one equipment company is reported to have delivered 150,000 cutting torch tips into the area in 1937 for use with gases other than acetylene.

The war brought a great increase in the need for metal cutting in thicknesses not customarily experienced. The amount of metal cutting required in armour and ship plate has grown considerably, and this has meant the search for better methods, quicker production, greater economy, fewer man-hours, and the elimination of handling difficulties. Oxypropane cutting appears to possess many of these advantages and it is used by many leading steelworks, foundries, etc.

The potential supply of propane is extremely large. Constancy of composition, flexible use and advantageous physical characteristics make it desirable for general processing work. It is particularly flexible for general foundry use. Its high heat content of 91,800 B.Th.U. per gall., and a range of available pressures without booster requirements permit its effective transportation through pipelines of small diameter yet in sufficient volume for any plant utilisation. The specific gravity is constant and balanced pressures are easily maintained.

Recent observations among a number of foundries have indicated that the use of industrial propane is increasing in marked manner, not alone for flame cutting but also for such work as annealing castings, baking cores, melting non-ferrous metals, preheating electric furnaces, drying moulds, heating ladles, as well as for miscellaneous laboratory and heating uses.

Simple Equipment

The equipment required for a plant installation is relatively simple. A storage tank of sufficient capacity to receive tank car loads is installed, usually above ground and connected to a plant piping system. Since propane exerts a vapour pressure of approximately 120 lbs. per sq. in. at 70 deg. F., this pressure can be reduced to that desired for burner operation by conventional gas regulators. Where the rate of use is high, vaporisation is accomplished by means of a heat exchanger. One of the best tanks is 57 ft. 4 in. long with a 15,000-gall. capacity and an 87-in. inside diameter. It is constructed in accordance with the A.S.M.E. unfired pressure-vessel code for working pressures of 200 lbs. per sq. in.

In the majority of installations, propane vaporises within the tank, passes out through proper pressure regulators into the service piping to the various gas-burning stations. It is piped round the plant at 30 lbs. pressure, and individual regulators at each outlet reduce the pressure to that desired for each job.

One of the most efficient industrial propane installations can be found at the plant of Dodge Steel Company, manufacturers of electric steel castings. This company produces carbon and alloy steel castings varying in weight from ¼ to 2,000 lbs. It delivers more than 50,000 castings per month. Tank car shipments of approximately 9,600 galls. or close to 880,000,000 B.Th.U. are stored in two 15,000-gall. tanks, for the use of industrial propane by this concern is unusually extensive. The plant was originally installed for heating purposes in June, 1936. The company were then gas-cutting gates and risers from small- and medium-weight carbon-steel castings. After some tests and providing proper tips and torches, it was decided that the use of propane had some advantages both in cost and operation. Since this original installation, all cutting has been with propane. In this six-year period the uses of propane in this plant have been unusually extensive.

Cost and Safety

While it is difficult to obtain accurate comparative costs due to the large number of variables in the size, shape, location and cleanliness of gates and risers on steel castings, it is probable there has been no over-all increase in oxygen consumption. A reduction of cuts on the sprue cutter, increasing the area of gates and risers formerly cut on the sprue cutter by 15 per cent., thus increasing production at no increase in cost, has shown a decrease of oxygen consumption of about 8 per cent. per unit area of metal cut in other comparative tests of long duration.

Buying propane in bulk, its cost for cutting is lower than that of the fuel previously used. The piping of propane to the location of cutting operations at any desired pressure is simple and safe. The handling of cylinders and disposal of sludge are eliminated. Of course, Dodge operations have been tremendously expanded, and the economy of just the matter of eliminating the handling of bottles is huge. There are data to prove that the amount of propane for cutting a cross-sectional area of 76,000 sq. in. is only 850 cub. ft.

Propane has also proved extremely easy to handle and there is little possibility of its exploding. Because of its low burning temperature, it is not likely to fuse to adhering sand or slag at the surface to be burned, which allows great latitude in the cleanliness of the casting that can be cut—an important consideration.

Oxypropane Cutting

Operators say they would rather burn with propane because it is easier to handle when sand, scale, or other inert materials are encountered. According to one authority, a No. 5 tip is used to burn sections up to 16 in. in dia., using 65-lb. oxygen and 20-lb. propane pressures. Tip size No. 4 is used with 45 lbs. of oxygen and 20 lbs. of propane to burn sections up to 6 in. in dia.

Cutting Technique

A very narrow kerf is obtained with the oxypropane flame, and slag adherence is practically nil. A small kerf is, of course, indication that a small volume of steel is being burned away. Every cubic inch of steel removed naturally requires a definite amount of oxygen to effect such oxidation. Thus, a clean, narrow kerf is proof of oxygen economy. Dodge experience in cutting risers is that successful results are obtained without resorting to the use of an oxygen lance. This is unusual in that some of the castings produced have risers up to 21 in. in dia. The oxypropane cutting torch does not tend to carburise or case-harden the edges of the metal. This makes for low machining costs.

It was once believed that oxypropane cutting time was slower, but this is quite disproved. Once the action is started, it is the oxygen that burns up the metal in the cut. The function of the flame is mainly to maintain, control and direct the course of the oxidation. The lower flame temperature and flame speed appear to result in a more perfect oxidation and a more rapid cutting speed.

The average torch operator required five days, sometimes less, to become familiar with using the oxypropane torch. Some patience is required to attain proper "feel" and manipulation. Cutters find that the quickest technique is to cut parallel to the greatest thickness wherever possible. To reduce preheat time, cuts should be started at some point which presents a rough edge rather than a smoothly rounded surface. The oxypropane flame does not require a clean surface for the cutting operation, which reduces the amount of the cleaning and chipping required to prepare castings for cutting.

Aside from riser cutting, other industrial propane uses are being extended. Propane has replaced oil for annealing castings, in many instances permitting closer control over scaling conditions and operating temperatures. And when drying cores, the use of automatic temperature control with industrial propane lessens the hazard of burned cores. In fact, a better quality of core results. Smoke and fumes are also eliminated. Propane is also advantageous for the skin drying of moulds. Having a specific gravity of 1.5, a fairly rich setting of the mould-drying torch produces a heavy air-gas mixture with high penetration through every portion of intricate moulds and particularly those points below floor levels that are difficult to reach by other methods. A drying depth of better than 6 in. is easily obtained.

NEW A.S.T.M. SPECIFICATION FOR HIGH QUALITY ALUMINIUM AND ZINC DIE CASTINGS

The American authorities have published a fresh specification covering high quality aluminium and zinc pressure die castings, using at least 1,100 lbs. per sq. in. Designated XXXIII and XXXV, the alloys have to conform to the chemical and physical requirements set out in Tables I and II.

TABLE I.—*Chemical Requirements (per cent.).*

	Alloy No. XXXIII	Alloy No. XXXV
Cu	0·10 max.	0·75—1·25
Al	3·75—4·25	3·75—4·25
Mg	0·03—0·05	0·03—0·05
Fe, max.	0·100	0·100
Pb, max.	0·007	0·007
Cd, max.	0·005	0·005
Sn, max.	0·005	0·005
Pb + Cd + Sn, max. ..	0·010	0·010
Zn	Remainder	Remainder

TABLE II.—*Physical Requirements.*

	Alloy No. XXXIII		Alloy No. XXXV	
	Average of specimens tested*	Individual specimens	Average of specimens tested*	Individual specimens
As received :				
Tensile strength, min., tons per sq. in.	15·6	13·4	17·8	14·3
Elongation per cent. in 2 in., min. ..	3	2	2	0·5
Impact, min., ft.-lb.	12	8	12	8

* Average of tests on at least 5 tension specimens and 10 mpact specimens.

War production and post-war problems of the foundry industry was discussed recently by the North-Eastern Ohio Chapter of the American Foundry's Association. Mr. A. J. Tuscany, commissioner of the Metal Lathe Manufacturers' Association, urged simplification of foundry methods as the best means of attaining peak wartime production. He cited the recent employment of women in Cleveland foundries as coremakers' and moulders' helpers as proof of America's precedent-breaking adaptation to the labour emergency. He added that he knew of no employment of women in foundries there previous to 1943. Even though the foundries in the United States now employed between 300,000 and 500,000 men, the huge post-war demands for products whose sale was now restricted or banned would keep them working.

HEAVY MOULDING BOXES

By Jas. Timbrell

The design of moulding boxes for heavy castings and to take patterns with probabilities of subsequent alterations, which may necessitate more or less moulding space, is a problem of some importance to foundry executives—it can also be an expensive one. Box parts, cast *en bloc*, to a design for semi-standard work, and made suitable to take a particular range of patterns, have the advantages of rigidity and strength to recommend them. Usually, these made-to-measure boxes take less moulding time in production and are also more quickly put into service. For semi-jobbing work, or other reasons of variations in style, the built-up moulding box, with its wider possibilities for simple alteration or additions, merits comparison. These assembled boxes can be designed to cover a wider range of similar kind of patterns. The extra cost of fitting sections and bars together is reduced by the saving in patternmaking and timber, whilst the simplicity of moulding the open-sand cast sections is obvious.

Where stresses are anticipated and points of strain countered with brackets, a lighter, yet stronger, box can be designed with safety. The loss of rigidity, compared with the cast-in-one-piece type, is not detrimental if the lifting chains have the adjustable tension screws for levelling. On extra long boxes, any out-of-winding can be checked and taken out by using sighting bars at each stage in the moulding, drying and setting down.

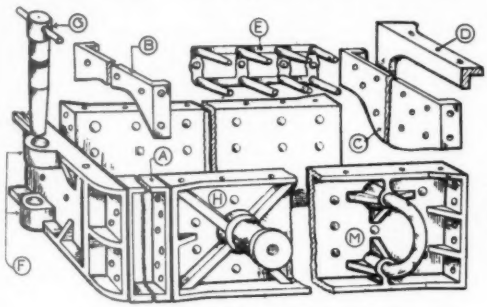

Fig. 1.

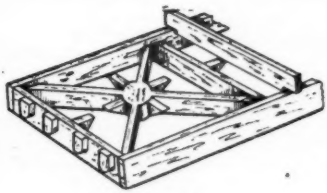

Fig. 2.

The main components in a built-up moulding box are, of course, two sides, two ends and box bars, to follow, where desired, the profile of the pattern in the top half-box. For the long boxes, strainer or bottom bars are fixed at suitable spacings and a drag (maybe a grid) to bolt on for the last course of ramming.

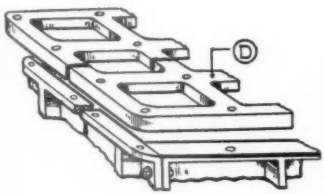

Fig. 3.

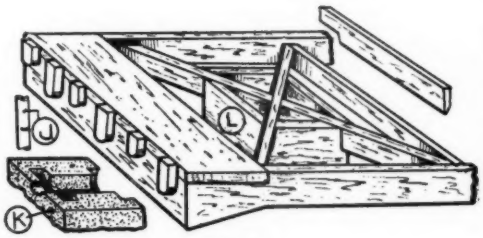

Fig. 4.

Fig. 1 shows a group of the different applications of the main features; modifications and alterations will suggest themselves to suit individual requirements. Fig. 2 shows the type of skeleton framing for easy ramming, and casting open-sand, one-half of one section, plus a few inches beyond the centre line, will mould end-for-end and produce a full-length section. A strickle, shown in Fig. 2, is used to take out section thickness. Cored holes should be incorporated on simple dimensions; for example, if all cored holes are to be 1¼ in. dia., and 12-in., 9-in., 6-in. and 3-in. centres, whenever additional bars or grids are to be added, the required centres will be easily matched.

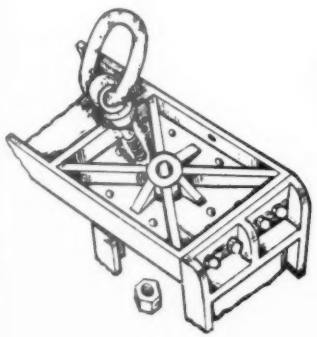

Fig. 5.

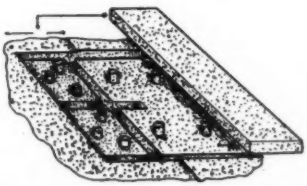

Fig. 6.

At A in Fig. 1 is shown a sectional

Heavy Moulding Boxes

piece for lengthening the box, for a 2-ft. or more addition. It is advantageous to equalise, by putting a half-piece of the total each end in order to retain lifting balance; it will be noted that the end sections come outside the actual moulding space. B shows a type of profile top bar, which, of course, may be shaped to the pattern outline; C is a type of bar for lifting out parts of the mould which are deeper than the joint, and are part of the top half-lift. D is a strainer or bottom bar; these can be cored to register with the bottom drag holes, as shown at D, Fig. 3. The core-iron type of grid E, Fig. 1, is a useful item for bolting on to the side in the top, to carry a bulk of sand which would otherwise have to be reinforced with lifters. Double lugs for closing pins control the accuracy of the joint match, and large diameter closing pins G will resist any tendency to swing out of register.

Lifting Details

Cast-in machined steel trunnions are common-place on boxes which are turned over endwise or if these are lowered into pouring pits for casting on-end. Cast-iron trunnions of larger diameter than steel can be substituted with safety, if a piece of steel bar of suitable diameter be cast-in, in the centre of the trunnion, shown at H (Fig. 1); a saw-cut (J, Fig. 4) nearly through the bar, before this is pushed into the bed, will facilitate the removal of the protuding piece left on the finished casting. Fig. 4 also shows a part of the skeleton pattern and coreprint L, whilst a cutaway section of a half trunnion core is shown at K. One half core box, two half cores stuck together, are put into the print formed by L.

Lifting chain hooks or other "slinging" details should be borne in mind when designing cast-iron trunnions. M (Fig. 1) shows a section of the staple for hook lift. This type of curved lifting detail makes for easy rolling, and chain snatch is unusual, as sometimes happens with the square type of lifting staple. These should, of course, be of substantial diameter and well bracketed to strengthen. Local strains and future probable additions to the weight should be allowed for.

The detachable swivel link, shown in Fig. 5, is a popular type of lifting detail for hook lift. One set may serve for more than one box, providing one box is wanted at a time, as obviously these swivel hooks cannot be detached from a rammed-up mould. Fig. 5 also shows a cut-away section, suitably bracketed at the boss, and the skeleton pattern (Fig. 2) shows part of the pattern for this.

Box sides and ends, which are cast open, carry an inherently rough surface, and the hotter these are poured—preferably running from each end for long sections, in conjunction with a well-vented, correctly-tempered bed—the smoother they will be on the face. A rough or lumpy surface can mitigate against easy assembly, or when changing the bars. The profile and bottom bars should be made a little shorter in the length, as this variation can be taken up with washers. This method is much easier than fettling or machining away obstructing material. To obtain a smooth surface at the end faces, which are cast uppermost, a slab of flat core placed over this part, ¼ in. below the expected finish of the flow, will ensure a satisfactory face for level, "square" bolting up. Fig. 6 shows the method, and incidentally this cover core will ensure clean "square" bolt holes.

INSTITUTE OF BRITISH FOUNDRYMEN

(*Continued from page* 13)

patternmaker, Fullwood Foundry, Bellshill; S. Hanson, ironmoulder, Turner Textile Machinery Company; W. C. Haslock, chargehand moulder, W. Shaw & Company, Limited, Middlesbrough; P. L. Lee, time study engineer, Langley Alloys, Limited, Bucks; J. McMiller, foreman moulder, Smith & Wellstood, Bonnybridge; G. Morris, assistant metallurgist, Head Wrightson & Company, Stockton-on-Tees; J. McCallum, ironmoulder, Fullwood Foundry, Bellshill; F. R. Nelson, foundry laboratory assistant, Clyde Alloy Steel; J. R. Nicolson, analytical chemist, Davy & United Roll Foundry, Limited, Haverton Hill; O. Smith, patternmaker, Reavell & Company, Ipswich; J. F. Roberts, technical advisor, I.C.I., Limited; W. T. Underhill, foundry foreman, Carron Company; J. P. Warner, foundry foreman, B. Rhodes & Son, Limited, London; W. Watson, plant foreman, Stockton Steel Foundry Company; C. M. Acott, foreman, Harrison & Company (Lincoln), Limited; J. Barnes, engineroom artificer; C. H. Bird, air furnaceman, Harrison & Company (Lincoln), Limited; H. W. Creasey, foreman, Harrison & Company (Lincoln), Limited; T. Exton, moulder, Harrison & Company; B. Hamblett, engineroom artificer; J. Horrocks, superviser (stores), Harrison & Company (Lincoln), Limited; G. H. Limmer, chargehand patternmaker, Langley Alloys, Limited; T. L. Marshall, air furnaceman, Harrison & Company (Lincoln), Limited; J. Norcliffe, foreman coremaker, Qualcast, Limited, Derby; C. H. Norris, metallurgical laboratory assistant, Harrison & Company (Lincoln), Limited; Oakes, J. N., metallurgical laboratory assistant, Harrison & Company, Limited; J. H. Reading, air furnaceman, Harrison & Company, Limited; T. N. Scotton, metallurgical chemist, Qualcast, Limited, Derby; J. W. Wattam, hard casting inspector, Harrison & Company (Lincoln), Limited; C. A. White, annealing foreman, Harrison & Company (Lincoln), Limited; J. Mountford, director and foundry manager, Hanley Foundry Company, Limited, Stoke-on-Trent.

Transfers from Associate to Associate Member

H. Thompson, moulder, R. Haughton, Limited, Nelson; H. P. Millar, metallurgist, Glenfield & Kennedy, Limited, Kilmarnock; J. G. Ogilvie, foreman moulder, Argus Foundry, Thornliebank.

Associate

H. Dean, moulder and coremaker, Ley's Malleable, Derby; C. Gleadhall, foundry foreman, J. Dale, Limited, London.

INSTITUTE OF BRITISH FOUNDRYMEN

NEW MEMBERS

At a meeting of the Council of the Institute of British Foundrymen, held at the Midland Hotel, Manchester, on April 17, the following 114 applicants were elected to the various grades of membership.

As Subscribing Firm Members

Apex Metal Company, Bradford; representative, J. Holmes.—Metronic Instrument Company, Limited, Smethwick, Staffs; representative, H. A. Hallett.—Scott Motors (Saltaire), Limited, Shipley, Yorks; representative, W. Cull.—Turner Tanning Machinery Company, Stanningley Road, Bramley; representative, G. A. Schettler.—Albion Motors, Limited, Scotstoun, Glasgow; representative, A. C. MacDonald.—John Dale, Limited, New Southgate, N.11; representative, B. L. Page; High Duty Alloys, Limited, Slough; representative, W. C. Devereux.—Langley Alloys, Limited, Langley, Bucks; representative, G. Skript.

As Members

J. Addy, works manager, J. Addy & Son, Huddersfield; T. R. J. Brown, foundry manager, New Rock Foundry, Monmouth; N. Daglish, managing director, Bartles (Carn Brea), Limited; D. F. Frost, foundry manager, Yorkshire Engineering Supplies, Limited, Leeds; C. Gillespie, foundry foreman, Newton Chambers, Sheffield; B. Gray, works superintendent, English Steel Corporation, Sheffield; J. E. Harle, foundry superintendent, Mather & Platt, Manchester; H. Howard, foundry foreman, J. Hodgkinson & Company, Oldham; W. E. Hunt, managing director, Bristol Foundry Company; T. Hunter, metallurgist, Alston Foundry Company, Limited; R. G. Hutchinson, mechanical engineer, J. Hutchinson & Company; S. Jan, assistant inspection officer, Kulti, India; P. L. Lodha, steel foundry chemist, B.B. & C.I. Rly. Lab., India; J. Myers, metallurgical chemist, G. Rudd, Thompson & Partners, Newport; A. J. Rostron, foreman moulder, Magnal Products, Bristol; R. Storey, ironfounder, The Storey Foundry Company, Cheshire; C. H. Wilson, foundry engineer, India; R. T. M. Toyn, Engineering Naval Officer; W. A. Baker, research metallurgist, B.N.F.M.R.A., London; L. R. Carr, metallurgical radiologist, J. Dale, Limited, London; R. Dickie, agricultural engineer and implement maker, W. Dickie, East Kilbride; W. J. Gibson, foundry manager, J. & R. Ritchie & Company, Middlesbrough; G. Hobman, metallurgist, International Meehanite, London; R. Jones, metallurgist, High Duty Alloys, Limited, Slough; F. L. Levy, director, steelfoundry, Kryn & Lahy, Limited, Letchworth; R. F. Lockyer, assistant manager and chief designer, Scottish Precision Castings; B. Milton, chief engineer, Thos. Turtons, Limited, Sheffield; F. Palmer, foundry superintendent, Cronite Foundry Company, London; C. A. Peake, company secretary and commercial manager, Watford Foundry Company; I. Ross, branch manager, High Duty Alloys, Slough; D. M. Webster, technical manager, Alex. Shanks & Son, Limited, Arbroath; C. V. Lineham, foundry works manager, Stanton Ironworks; E. Regan, foundry manager, International Alloys, Slough; J. W. Dews, metallurgist, J. Harper & Company, Limited.

Transfers from Associate Member to Member

L. W. Bolton, metallurgical engineer, B.C.I.R.A.; W. Brown, bronze foundry manager, Mather & Platt, Limited, Manchester; E. J. L. Howard, metallurgist, Mather & Platt, Limited; W. Dickie, brassfounder, Paisley Brass Works; R. Parish, production manager, South Wales Metal Refiners, Limited, Port Talbot; L. Turner, moulder, Bradley Mills, Elland, Yorks; A. Hopwood, foundry manager, Harland & Wolff, Limited, Liverpool.

As Associate Members

J. Bedford, foreman patternmaker, J. N. Chadwick, Limited, Bolton; H. Birkhead, moulder, Crofts (Engineers), Limited, Bradford; J. Booth, moulder, Dobson & Barlows, Limited, Bolton; S. A. Bosworth, chemist, Newman Industries, Limited, Bristol; A. Childs, foundry foreman, F. Parramore & Sons, Sheffield; A. H. Climas, foreman patternmaker, Holman Bros., Camborne; W. E. Connah, assistant foreman moulder, J. N. Chadwick, Limited, Bolton; A. Cook, foundry foreman, Coneygre Foundry, Dudley; A. Dobson, mechanical engineer, Phillips Blackburn Works; R. G. Duckett, technical representative, Foundry Services, Limited; R. Higgins, foundry inspector, Modern Foundries, Halifax; L. W. Hobday, technical representative, Foundry Services, Limited; J. Hunt, moulder, J. H. Smethurst & Son, Warrington; G. Jackson, patternmaker, Dawson, Payne & Elliott, Otley; A. T. Johnston, foundry supervisor, Midland Motor Cylinder Company, Smethwick; J. Kein, foreman patternmaker, Muir Machine Tools, Manchester; D. Knowles, metallurgist, Hadfields, Limited, Sheffield; R. Laycock, metallurgist, J. Blakeborough & Sons, Brighouse; A. Longden, foundry foreman, Craven Bros., Limited, Manchester; F. C. Manning, engineer and draughtsman, Bradley & Foster, Darlaston; A. G. Mettam, technical assistant, Hadfields, Limited, Sheffield; R. A. Miller, assistant technical advisor, Foundry Services; G. W. Moisley, foreman moulder, S. Fox and Company, Deepcar; J. Moran, chargehand moulder, Modern Foundries, Halifax; W. S. Oxley, rate fixer, English Steel Corporation, Sheffield; H. Peck, foreman moulder, S. Osborn & Company, Limited, Sheffield; A. Redfern, foreman moulder, S. Osborn & Company, Limited; S. G. Richards, sample passer, Brown Lenox, Pontypridd; W. Rigby, foreman, Hargreaves & Jennings, Limited, Bury; W. J. Roskrow, metallurgist, Holman Bros., Limited, Camborne; R. H. Walker, moulder, Aiton & Company, Derby; J. A. Waller, patternmaker and foreman, Indian Iron and Steel Company; G. Whitehouse, engineer's draughtsman, English Steel Corporation, Sheffield; R. Wood, engineer, Nicholl & Wood, Halifax; R. Barnes, technical assistant and works manager, Firth-Brown, Ministry of Supply, Scunthorpe; C. R. Booth, manager's assistant, Hartley's Malleable Fittings Company, Limited, Halifax; C. Brooks, technical representative, Foundry Services, Limited; R. J. Cooper, furnaceman, H.M. Dockyard, Plymouth; J. Grant,

(*Continued on page* 12)

BLAST-FURNACE LININGS

A STUDY OF THE MECHANISM OF WEAR

The mechanism of wear of blast-furnace linings is discussed by HOBART M. KRANER, of the Bethlehem Steel Corporation, in a recent issue of "Steel," in the course of which he states that judging from the bibliography and the results of recent critical studies of worn-out linings, modern linings are being worn out by the same processes reported over the last 40 years.

Up to the present time the greatest attention has apparently been centred upon disintegration of the refractory caused by a deposition of carbon and swelling of this carbon in its pores. Failures, which are due to this cause, at an early stage in a campaign may be explained by unfavourable temperature and atmospheric conditions. Two furnace failures coming under the author's personal observation could be thus explained, and the situation was remedied in subsequent lining installations. The process by which this disintegration takes place was an early discovery, recognised by Gruner in 1870-73. It is generally understood that metallic iron, Fe_2O_3, Fe_3O_4, carbides, and zinc are the principal catalysts accelerating the reaction which precipitates carbon within the pores of the refractory, as follows:

$$2CO \Longleftrightarrow C + CO_2$$

With all that has been written on this subject, there is still little quantitative information available about the relative importance of each of these catalysts. This is also the reason why the iron oxide content of a refractory cannot be used as a means of determining quantitatively its ability to withstand disintegration by carbon deposition.

Alkali Attack

Alkali attack is next in importance, or possibly nearly as important as carbon deposition. This action has been found to take place in the upper part of the bosh and the lower part of the stack. Small amounts of alkalis in the constituents of the furnace burden volatilise and penetrate into the refractories. The large amounts of alkalis found are accumulations from this source. These alkalis react with the brickwork to form nephelite ($Na_2O \cdot Al_2O_3 \cdot 2SiO_2$). Micro-sections show the plastic fireclay to have been almost entirely dissolved. As the bricks have the approximate composition $Al_2O_3 \cdot 2SiO_2$, the formation of nephelite is relatively simple, if conditions are otherwise favourable. The presence of large amounts of nephelite in the brick-scab interface shows that the bricks have been fluxed and that the high alkali content of samples collected from this zone of the furnace is not simply impregnation as would be suspected if only chemical analyses had been obtained. The nephelite is really a reaction product which indicates the course of the reaction.

The term "slag attack" as applied to blast-furnace refractories has been used rather carelessly. Blast-furnace slag is not guilty of much refractory attack, except in the bosh and upper hearth sections. As the coke is not burned and the ash is not available until it reaches the bosh, the slag exists only in the lower bosh section. The hearth is water-jacketed and the bosh is extensively water-cooled by copper bosh cooling plates extending through the lining. Otherwise, the bosh refractories would last only a short time due to the high temperature and corrosive action of the basic slag-forming constituents.

Little slag action occurs above the mantle inasmuch as there is little coke ash available to form slag above that point. Lime and iron oxide might be expected to flux refractories above the mantle, but there is not much evidence of this being the case. Only minor quantities of lime-bearing minerals are present in the brick-scab interface, and the lime and magnesia is also small.

Abrasion

Much is said about the serious effect of abrasion on blast-furnace linings. Some operators place particular stress on the severity of this condition in their individual cases, due to certain ores or sinters in their burden. Judging from what has been seen in blown-out furnaces, it is believed that abrasion as such is only a secondary cause of lining wear. The top section of the lining undergoes direct abrasion from the impingement of the charge as it falls from the bell, but this is alleviated by metal wearing plates anchored in the lining in this section. Further down, the lines of a blown-out furnace usually show considerable scab upon which the real abrasion actually takes place. Wear in this section probably is due directly to a breaking off of relatively large pieces of scab which carry with them loose, weak pieces of disintegrated or fused refractory. The breakdown and weakening of the refractory responsible for this condition is caused by carbon disintegration or alkali reaction, or both.

In the zone about one-third of the way down from the top to the mantle the disintegrated area is fairly close to the working face. Here it appears that disintegration contributes heavily toward breaking away of thin layers of good refractory. Scabs form and break off through zones of the brick which were weakened by carbon disintegration.

The scabs which form on the lining further down take the brunt of the descending charge. Only a

Blast-Furnace Linings

small part of this scab is brickwork. It is generally a consolidation of stock, alkalis and small lumps of bricks finding their way into the descending burden. The zone between the scab and the solid bricks contains lumps of bricks which have disintegrated, but which have not been consolidated. From these observations it would appear that the effects of the so-called abrasion should be properly assigned to the pressure of the descending charge which breaks the scab from the brick face. Due to the altered condition of a brick face weakened by carbon deposition and alkali attack large sections of scab may be removed in this manner.

Mechanism of Combined Attack

The combined action of carbon disintegration and alkali attack is responsible for the bellied lines a short distance above the mantle and operates somewhat as follows:

The intense zone of carbon disintegration develops where the temperature is 450 to 550 deg. C. (842 to 932 deg. F.). At the top, this zone is wider than at the mantle. It is near the inner face at the top and closer to the shell at the mantle. At the latter point high temperatures and severe alkali attack also are encountered. As the alkali reaction removes brick face the temperature gradient between working face and shell changes, and the disintegrating zone advances toward the shell. Alkali attack and the advancing disintegrating action therefore proceed simultaneously. By the time alkali attack has removed the part of the brickwork, the temperature of which was always above 550 deg. C. (932 deg. F.), carbon disintegration has been so effective near the shell that practically nothing remains to support the upper brickwork. Irregular slag analyses, especially in respect to the alumina content, frequently are observed, and these are generally considered to be due to sloughing off of such unsupported slabs inside the weak, disintegrated zone.

In the hearth the ferrostatic pressure and the high temperature are sufficient to vitrify the brick face. Before the vitrification is completed the bricks are frequently so porous that the molten metal may penetrate into the pores. Vitrification causes shrinkage which may be heavy enough to allow the bricks to float out. Bricks 4½ in. thick often shrink to 4 in. thick in this zone. Volume stability is therefore essential here.

Chemical attack by the metal in the hearth would be expected to be low. Iron sulphide dissolved in the metal might be corrosive, but actually lime and magnesia seem to be the fluxes here, as the principal minerals found on the face of bricks under the metal bath are lime-magnesia compounds and anorthite (CaO-Al_2O_3-$2SiO_2$).

It is not clear just how the lime and magnesia get down into the metal bath in the hearth, but it is probably carried under by agitation of the liquid metal. Some doubt might be cast upon the lime attack theory on the basis that these minerals may have been formed when slag was spread over the brick face as the salamander was drained. If the lime-magnesia attack theory is discarded, only the actual fusion and shrinkage of the brickwork remain to explain the wear in the hearth.

In order to differentiate between simple penetration and contamination, a petrographic study was made of the mineral distribution on the exposed face (scab) and on the brick-scab interface. The brick-scab interface is that portion of the wall in which brick could be definitely distinguished. From the occurrence of the various chemical constituents it is also possible to deduct what reactions actually have taken place. Presence of large quantities of nephelite shows that the alumina and silica, presumably from the refractories, have combined with the alkali. The amount of lime-bearing minerals in this zone is low, indicating that lime is not an important factor in lining attack above the mantle. Olivine is present to a larger extent in the scab. Considerable quantities of nephelite also are found.

Brinell Hardness and Tensile Strength

In a recent issue of "Abnahme," A. PUSCH reports on a statistical analysis of the relationship between tensile strength and Brinell hardness for cast steel with tensile values between 38 to 70 kg. per sq. mm. and locomotive tyres between 80 and 110 kg. per sq. mm., with the object of arriving at a conversion factor which might be of use as an acceptance test.

Compressed Magnets with Artificial Binder

In "Stahl und Eisen" of November 19 last, H. DEHLER describes a process for the production of permanent magnets based on powder-metallurgy principles, designed to overcome the difficulties in machining cast magnets made from Fe-Ni-Al, Co, Cu and Ti alloys. The alloyed material is prepared in a pulverised state and treated with an artificial resin to act as a binder, pressure and heat being applied to obtain a homogeneous pressed product; the temperature employed is not high enough to produce sintering. This process facilitates the attachment of lugs, etc., to the magnets, which can also be perforated as desired. No machining of the finished magnet after leaving the die is required. The author claims that the process is very quick, and that the magnetic values of the products are only about 20 per cent. below those measured on cast magnets. The process is adaptable for serial production.

STOKER AND FURNACE MAKERS' ASSOCIATION

An association has been formed to focus the attention of all who are interested in promoting the better use of coal in firing shell-type boilers. While retaining the freedom of individual manufacturers to develop their own appliances, makers of stoker and furnace equipment for shell-type boilers have united to set up the Stoker and Furnace Makers' Association. The objects of the new Association are to encourage the production of efficient appliances and to maintain a high standard of workmanship in all developments in design while deprecating extravagant performance claims. The Association will also represent the interests of its members in negotiations with Government departments, trade associations, scientific bodies and industrial purchasers. Foremost among its objects will be to define and support guaranteed standards of performance and to promote co-operative research into stoker and furnace design with a view to increasing their efficiency and extending their field of application.

The founder members are:—British Doby Stokers, Limited, London; Crosthwaite Furnaces & Scriven Machine Tools, Limited, Leeds; James Hodgkinson (Salford), Limited, Salford, Lancs; Meldrums, Limited, Timperley, Manchester; J. & J. Neil (Temple), Limited, Glasgow; Niagara Engineering Company, Limited, London; James Proctor, Limited, Burnley; Superheat Furnace Company, Bradford; John Thompson (Triumph Stoker), Limited, Leeds; the Turbine Furnace Company, Limited, London; Whitehead Bros., Limited, Farsley, Leeds.

The address of the S.A.F.A. is Rickett Street, West Brompton, London, S.W.6. The secretary will be pleased to receive inquiries and suggestions from users of plant of the type manufactured by members of the Association.

PERSONAL

MR. A. W. BERRY has been appointed to succeed Mr. D. A. Bremner as director of the British Engineers' Association. Mr. Bremner retired on April 30.

MR. GEORGE BAKER, managing director of John Baker & Bessemer, Limited, has been elected president of the Sheffield and District Engineering Trades Employers' Association. He succeeds Sir Samuel Osborn, who has been president for seven years.

MR. E. J. RICHARDS, until recently technical manager of the Verichrome Plating Company, Wallows Lane, Walsall, has been appointed a director of the company and also of the parent company, the Aluminium Bronze Company, Limited. He joined the firm some eight years ago.

Wills

HUPTON, H. R., of Wolverhampton, iron and steel merchant	£5,905
KIRKPATRICK, G. L., managing director of Bruce Peebles & Company, Limited	£6,693

NEW PATENTS

The following list of Patent Specifications accepted has been taken from the "Official Journal (Patents)." Printed copies of the full Specifications are obtainable from the Patent Office, 25, Southampton Buildings, London, W.C.2, price 1s each.

550,778 RAKOS, A. Methods of welding, soldering, and fusing metals together.

550,828 WAGNER, R. L. Coating metal articles by deposition of metal by welding.

550,842 EVERY, C. E. (Electro Manganese Corporation). Electrolytic recovery and deposition of manganese and materials for use therein.

550,847 E.M.B. COMPANY, LIMITED, SMITH, S., and COCKERILL, W. H. Machines for casting metal under pressure.

550,864 DANIELS, LIMITED, T. H. & J., and DANIELS, J. L. Cold chamber die-casting machines for aluminium, brass, and the like.

550,927 BRITISH CAST IRON RESEARCH ASSOCIATION, PEARCE, J. G., and MORGAN, E. Manufacture of pig and cast iron.

550,996-7 JAMES & COMPANY (BIRMINGHAM), LIMITED, and ANDREWS, H. Centrifugal casting machines.

551,013 BULL, G. H., and ALLSOP, H. Decarburisation of alloy steels.

551,018 SHORTER PROCESS COMPANY, LIMITED, and SHORTER, A. E. Heat-treatment of metal surfaces.

551,103 TRIGGS, W. W. (Carnegie-Illinois Steel Corporation). Method of continuously conditioning conductor rolls in continuous electroplating processes.

551,261 PYRENE COMPANY, LIMITED (Parker Rust-Proof Company). Production of coatings on metal surfaces.

551,309 NEWTON, CHAMBERS & COMPANY, LIMITED, and TUCKER, R. C. Coating of surfaces.

551,327 STAVELEY COAL & IRON COMPANY, LIMITED, and FREER, E. Pipe joints.

551,339 FLINT, C. F., TAYLOR, H., and IMPERIAL CHEMICAL INDUSTRIES, LIMITED. Applying protective coatings to surfaces.

WOLVERHAMPTON STEEL & IRON COMPANY

A new board of directors has been appointed for the Wolverhampton Steel & Iron Company, Limited, Osier Bed Works, Wolverhampton, consequent upon the resignation for health reasons of Mr. W. J. Spence-Thomas, chairman and managing director since 1936. His fellow directors, Mr. W. W. Hickman, Mr. J. Campbell Ritchie, Mr. H. A. Spence-Thomas and Mrs. G. A. Spence-Thomas, have also resigned.

The new board includes Sir Basil R. G. Tangye (chairman), Mr. William Peel Fletcher (managing director) and Mr. Mansfield Markham. Mr. W. W. Thomas continues as secretary.

Sir Basil Tangye is chairman and managing director of Tangyes, Limited, Smethwick, and chairman of Kitson & Company, Limited, Leeds. Mr. W. P. Fletcher is managing director of Kitson & Company, Limited.

NEWS IN BRIEF

THE LONDON STOCK EXCHANGE COMMITTEE has granted permission to deal in respect of the £290,150 ordinary stock of the Briton Ferry Steel Company, Limited.

THE LONDON OFFICE of Holman Bros., Limited, has been transferred from emergency quarters at Potters Bar to Broad Street House, Old Broad Street, E.C.2.

SIR JOHN DUNCANSON and Mr. Earl A. Emmerson, who are making an Anglo-American survey of the steel situation in Australasia, South Africa and India, have arrived in Australia.

A LARGE IRONWORKS is being built at Lulea in North Sweden by the Swedish Government at a cost of 17 million Sw. kr., to smelt iron ore and to reduce Sweden's requirements of imported scrap.

THE IRON AND STEEL TRADES CONFEDERATION has signed an agreement with William Dixon & Company, Limited, Govan Ironworks, Glasgow, to regulate the wages and conditions of employees at the coke-oven plant. It will increase the standard wage by 1s. per shift.

THE COMPANIES REGISTRATION OFFICE gives notice that the names of the undermentioned companies have been struck off the register, and such companies are dissolved:—Birmingham Metal Stamping Company, Limited; Central Abrasive Company, Limited; Electrically Welded Products, Limited; Ferro-Chrome, Limited; High Vacuum Valve Company, Limited.

NORTH CHINA IRON MANUFACTURING COMPANY has been registered in Peking with a capital of 100 million yen, which has been subscribed in equal shares by the Japan Iron Manufacturing Company and the North China Development Company. It is proposed to develop an iron and steel industry in the region of Tientsin and Peking, and to concentrate the East Asian iron and steel industry under one control.

LT.-COMM. POWELL, OF H.M.S. GRIFFIN, recently visited the Griffin Foundry of Hunt Bros. (Oldbury), Limited, to congratulate the works savings group on its Warships Week effort and to show appreciation for the further interest taken in his ship by the works. The works group of under 150 men raised no less than £3,558—about £24 per man. Since its formation three years ago the group has raised £14,000.

THE EFFECT OF grain size on the physical properties of metals has been studied by various research workers. Interesting light on the part played by grain size in the properties of pure tin and tin-rich alloys is given in the Tin Research Institute's publication No. 118, which is a reprint of a Paper by Dr. W. T. Pell-Walpole in the Journal of the Institute of Metals. Copies of this publication may be obtained free of charge from the Tin Research Institute, Fraser Road, Greenford, Middx.

THE APRIL ISSUE of the "Nickel Bulletin" includes abstracts dealing with the magnetic inspection of welds, the elimination of sulphur from town gas, hardening treatment and low-temperature mechanical properties of steel, and the conservation of the constituents of brass. Copies may be obtained free of charge, from the Bureau of Information on Nickel, Mond Nickel Company, Limited, Grosvenor House, Park Lane, London, W.1. Individuals are requested to give the names of their firms or otherwise indicate the nature of their interest.

THE COMMONWEALTH FUEL BOARD to the State Liquid Fuel authorities have directed that gas-producer outfits must be fitted to all commercial and agricultural motor vehicles. This will give much work to Australian manufacturers of producer-gas outfits as well as to makers of charcoal. Out of 228,942 commercial vehicles registered in Australia at June 30, 1942, 35,000 trucks had already been converted to gas. It is estimated that the conversion of the petrol-operated units will entail an outlay of about £13,575,940, *viz.*, an average outlay of £70 per unit, including cost of fitting.

LORD ABERCONWAY, presiding at the annual meeting of Thos. Firth & John Brown, Limited, said that while there had been no increase in the prices of the company's products, and in the case of some, quite substantial decreases, the trend of costs during the year had been definitely upwards. The company, in pursuance of the Government policy of dispersal, had opened branch factories for certain of its products on sites away from the main works. In addition, the company, at the request of the Ministry of Supply, had undertaken to build, organise, and operate three Government factories away from Sheffield, for the manufacture of certain specialised requirements.

A WAGE AGREEMENT covering most of the clerical and administrative staffs in the light-castings industry in the Falkirk area has been reached between the Employers' Joint Committee and the Clerical and Administrative Workers' Union, dating from February 1 last. Under the agreement wages start at 17s. per week at the age of 17 for men and end at 92s. 6d. at the age of 27, with 15s. and 62s. 6d. for female workers. The standard rates may be exceeded at the discretion of the employer concerned. The rates agreed to include the cost-of-living bonus as at November 30. The working week is to be 42½ hours in the offices and 47 hours in works. Overtime will be paid at a flat time rate after 2½ hours' free overtime.

IN A REPORT on the payment of fire guards, the House of Commons Select Committee on National Expenditure recommends that the present variations should be brought to an end without delay, and that only the standard rates of subsistence allowance should be paid. The Report points out that fire guards in some 800 industrial establishments for which one or other of the Supply Departments is responsible, representing about 100,000 persons a week, are receiving payments in excess of the standard rate for fire watching. Their payments range from 5s. a night to 2s. an hour for exactly the same duties as others perform for the standard subsistence allowance of 3s. a night. Excess payments to this small minority of fire guards probably amount to several million pounds a year, the Committee states.

COMPANY NEWS

(Figures for previous year in brackets.)

Robey & Company—Dividend of 5% (same).

Henry Meadows—Interim dividend of 7½% (same).

Broom & Wade—Interim dividend of 7½% (same).

John Rigby & Sons—Interim dividend of 5% (same).

Brush Electrical Engineering—Ordinary dividend of 8% (6%).

Murex—Interim dividend on the ordinary shares of 7½% (same).

Allen West & Company—Net profit, £50,829 (£50,195); dividend of 7½% (same).

Heatrae—Net profit for the year to February last, £14,277 (£9,897); dividend of 12½% (same).

Associated Clay Industries—Net profit for 1942 of £12,026, reducing the debit balance brought forward to £2,808.

R. W. Crabtree & Sons—Dividend of 8% on the ordinary shares (same), together with a bonus of 2% (nil) out of the capital reserve account.

Halesowen Steel—Net profit for 1942, after taxation and contingencies, £20,383 (£20,096); final ordinary dividend of 17½%, making 25% (same); forward, £28,150 (£21,242).

British Lead Mills—Profit for year to October 31, £21,148 (£8,372); tax, £15,039 (£6,739); dividend of 10%, £3,750 (nil); to general reserve, £2,500 (nil); forward, £5,312 (£5,453).

British Oxygen Company—Net profit for 1942, £362,199 (£308,187); ordinary dividend of 15% (14%), £272,561 (£252,372); preference dividends, £43,312; forward, £114,804 (£67,478).

Superheater Company—Net profit for 1942, £78,776 (£133,116); preference dividends, £8,003 (£8,011); to tax reserve, £30,000 (£82,000); ordinary dividend of 37½% (same); forward, £17,801 (£17,631).

James H. Lamont—Net trading profit, £52,083 (£46,185); tax, £35,266 (£30,023); written off goodwill, patents, etc., £2,098 (£2,200); to general reserve, £3,000 (same); final dividend of 17½%, making 25% (22½%), and a participating dividend of 2% on the preference shares (same); forward, £1,975 (£1,910).

OBITUARY

MR. ALFRED STOTT, works manager of Dawson, Payne & Elliott, Limited, Ashfield Foundry, Otley, Yorks, died suddenly on April 21.

MR. JAMES HENRY HUXLEY, who was works chemist at Vickers, Limited, Sheffield, for nearly 60 years, has died at Bedford in his 92nd year. He retired in 1929.

MAJOR ROBERT WATERSTON FULTON, of Greenock, has been killed in action in North Africa, while serving with the Royal Artillery. Major Fulton was a director of P. MacCallum & Sons, Limited, iron and steel merchants, of Greenock. During service in France he was mentioned in despatches.

NEW COMPANIES

("Limited" is understood. Figures indicate capital. Names are of directors unless otherwise stated. Information compiled by Jordan & Sons, 116, Chancery Lane, London, W.C.2.)

Wimbledon Foundry Company, 93-97, Kingston Road, London, S.W.19—£4,000.

Ingot Metal Company, 146, Bishopsgate, London, E.C.2—£1,500. L. Austin and H. Levitt.

Nailsea Engineering Company, Heath Road, Nailsea, Somerset—£4,000. L. V. W. Storey and W. J. Hale.

R. Gibson & Company (Ruthin)—Engineers, etc. £5,000. R. Gibson, Bryn Hyfryd Park, Rhos Street, Ruthin; and R. Gibson, jun.

Wm. Molineaux & Son, Argyll Works, Alma Street, Smethwick—Iron and steel stockholders, merchants and fabricators. £2,000. R. C. and D. Molineaux.

Glaston Products, 38, Barnhill Road, Wembley, Middlesex—Processors of metals and alloys, metallurgists, engineers, etc. £2,000. C. T. J. and E. E. A. Seaton.

Henry Hardwick & Sons, Providence Works, Matilda Street, Sheffield—Founders, engineers, etc. £3,000. S., H., A. and W. Hardwick, W. Howarth, and L. Herbert.

Rubery Owen (Warrington)—£75,000. To acquire the general engineering part of the business of Rubery Owen Messier, Limited. A. G. B. and W. B. Owen and R. J. Norton.

Scott Engineering (Newport)—To take over the business carried on as "Scotts Engineering Works" at Stafford Road, Newport, Mon. £20,000. G., W. P., L., G. A., and A. Scott.

Heron Manufacturing Company (Wolverhampton), 4, Horseley Field, Wolverhampton—Manufacturers of capstan and general brass work. £1,000. J. F. Fenton, H. Simons, and A. Freeman.

A MILLOM & ASKAM DEVELOPMENT

During the last few months the Millom & Askam Hematite Iron Company, Limited, has had its new generating plant in operation and has made an arrangement for the sale of surplus electricity produced at the works from blast-furnace waste gases. The revenue from this is approximately £1,500 per month. Presiding at the annual meeting, last week, Sir Andrew Lewis, the chairman, said that this did not benefit the company while they were able to earn their standard profit from other products, but from the national point of view the transaction was of great value, as many thousands of tons of coal per annum were saved which would otherwise have been used in the production of the electricity. Blast-furnace production was satisfactory in quality and quantity throughout 1942, the chairman stated. Ore production continued steadily.

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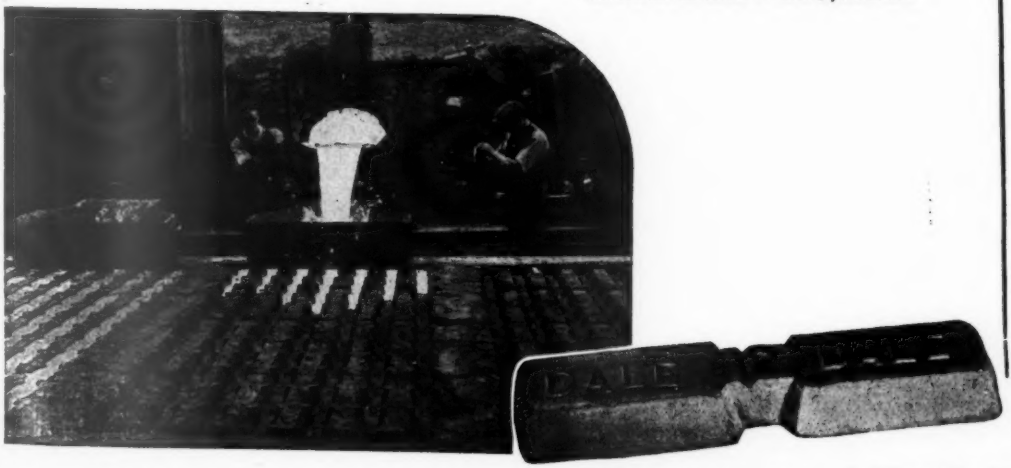

THE STANTON IRONWORKS COMPANY LIMITED, NEAR NOTTINGHAM

Raw Material Markets

IRON AND STEEL

There has been rather more activity in the light-foundry trade of late, and this has been reflected in the demand for high-phosphorus iron. Until recently comparatively few of the light foundries had been participating to any extent in Government contracts, but in increasing numbers they are adapting themselves to the manufacture of engineering castings, demand for which is maintained at peak levels. There is little business moving in ordinary light castings, domestic trade having been cut down to the minimum, while export orders, as a rule, are no longer permitted in view of the necessity of conserving raw materials and man-power. Ample quantities of high-phosphorus iron are available and many foundrymen have accumulated quite substantial reserve stocks, which, in view of their improved position, are likely to prove very useful.

Supplies of low- and medium-phosphorus iron, hematite and other better qualities used by the heavy engineering industry are, of course, much more difficult to secure, as they are produced from imported ores, whereas the ore needed to manufacture high-phosphorus iron is obtained in the United Kingdom. Consequently, users of the better descriptions have had to adjust their mixtures, which now include quite a large proportion of home-produced irons. For certain purposes, however, it is impracticable to deviate from established custom, and, where this is so, the Control are able to give delivery from stocks of the necessary grade.

The foundry coke position shows no deterioration and ample quantities are forthcoming to satisfy all requirements. Consumption is at a high rate, while there is also a considerable demand for coke for stocking purposes. There have been some reports of supplies from South Wales ovens being rather more rigidly controlled than is the case in other producing districts, but, on the whole, the situation is very satisfactory.

There continues to be a strong demand for finished steel. Alloy and special descriptions are needed in large tonnages for munitions and armaments production and, gratifying as the developments in the production of these steels have been, even bigger outputs could readily be absorbed. Ship and boiler plates are moving away freely, especially the former, which are in urgent demand all round. Sheets, too, are in insistent demand and mills are fully employed.

NON-FERROUS METALS

In the United States, as on this side of the Atlantic, the authorities are curtailing the use of copper where practicable and every effort is being made to conserve supplies for primary war needs. One of the latest American restrictions is the limitation of the use of the red metal and copper-base alloys for the manufacture of motor-car parts. It is expected that a substantial degree of economy will be effected. The American Lend-Lease Administrator, Mr. Edward R. Stettinius, recently stated that Lend-Lease aid to Russia was increasing. More than 94,000 short tons of copper and brass had been shipped to the Soviet already.

The Parliamentary Secretary to the Ministry of Economic Warfare, Mr. Dingle Foot, stated in the House of Commons recently that the United Nations had arranged to purchase the whole of Chile's exportable surplus of copper in 1943 and that there would be no exports of that metal from Chile to Spain.

Demand for spelter has been very extensive since the outbreak of war and consumption is still tending to increase. That the supply position is tight is no secret and it has been necessary to curb usage as much as possible. Stocks both here and in the United States are meagre compared with pre-war standards and are for emergency use only. So far all vital requirements have been satisfied promptly and it is confidently anticipated that, if the utmost care continues to be exercised in distribution, urgent needs will continue to be met. The American supply situation appears to have undergone a slight improvement of late, but the easier tendency may be only temporary and the authorities are guarding existing supplies very carefully.

Whereas there is little scope for non-essential usage of lead in the United Kingdom, on the other side of the Atlantic efforts are being made to enlarge allocations of the metal to civilian consumers, as the supply position there is comparatively easy. The U.S. Government continues to encourage domestic production and it is certain that any relaxations which the authorities might permit in respect of deliveries will not be very extensive until the position is further clarified.

LOCATION OF INDUSTRY ORDER

In the House of Commons, MR. BOWLES asked the President of the Board of Trade the reason for the extension of the Location of Industry Order to cover premises below 3,000 sq. ft. in area.

MR. DALTON said that under the Location of Industry (Restriction) Order, 1941, the starting up of any form of production in premises of 3,000 sq. ft. or over in area, or a changeover in the type of production carried on in such premises, was subject to the issue of a licence by the Board of Trade. With the progress of the war, it became essential to cover all premises, whatever their size, so that there should be no waste anywhere of our resources, whether of space, raw material or labour. Accordingly, following consultation with the Ministry of Production, an Order was made in October last abolishing the exemption of premises below 3,000 sq. ft. in area, and thus bringing within the Department's control all premises, whatever their area. The Order was administered in close consultation with the Regional Boards of the Ministry of Production. The Order also governed the use of premises for storage purposes.

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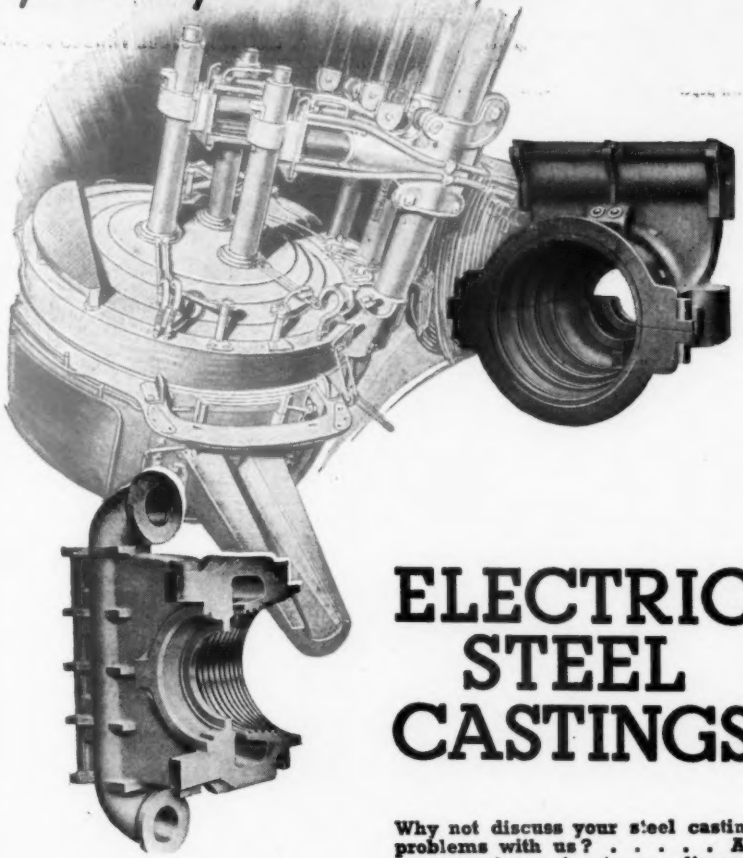

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FOUNDRY TRADE JOURNAL

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